In this clip, we're looking
at myeloid granulocytes, and to orient you, we're going to start with our
decision tree. The decision tree will
produce all of these cells, and these are the
four types we're going to look at in this clip. These are all myeloid
granulocytes. These cells as a group have lots of defensive
granules in them, they are all phagocytic to
some degree or another, and except for the male cells, they all have rather
odd-looking nuclei. Neutrophils are your first
and best line of defense. The neutrophil is the workhorse
of your immune system, and I sometimes refer
to it as the infantry. Because like our infantry, it puts boots on the
ground very quickly, and it's going to get there, be first on the scene, and
provide the most important initial
response to a threat. Here we have
neutrophil surrounded by erythrocytes or
red blood cells, and you can see the
unusual complex shapes of their nuclei. Here is a scanning
electron micrograph of a neutrophil phagocytizing
anthrax bacteria. You can see the complex surface, and you can see how it
changes
to grab this bacteria. This guy is strongly phagocytic, and they will really
give
up their lives swallowing 20 or more bacteria and finally essentially
poisoning themselves. Sadly, they typically
only live a day or two. While in modern warfare, we do not consider our
infantry to be cannon fodder, in the 1800s, a lot of
the powers that be did, which was a rather
sad commentary on the way they fought
wars in those days. Here we have two drawings that illustrate properties
of neutrophils. Both show the
segmented lobe nuclei and both show the
surface carbohydrates. The right-hand cartoon shows additional surface
molecules that are used to attach the neutrophil to an
inflamed epithelium. That is, it allows it to target
an infection directly so that it can go in and defend you from whatever
is infecting you. We also have here a picture of an antibody receptor
on the neutrophil, and these will pick up the
stems of antibodies after the adaptive immune system
has been activated. These guys can also
cooperate with your adaptive immune system to improve their efficiency
and effectiveness. Neutrophils have three
different forms of attack. Here we see one
neutrophil that's picking up bacteria by phagocytosis, here we see another
neutrophil that is defending you
by degranulation. Now, this picture
doesn't show it, but the granules and
neutrophils will stain with either red or
blue or both stains, and that's why they
call them neutrophils. But it suggests that
they have a selection of granules with different
defensive properties, and again, they can
release these things into the environment to help
defend you from threats. The most serious
defense a neutrophil can level is to actually do a kamikaze attack
on pathogens and burst opening up its
contents to the outside. Here you have something
that results. That is something
called net production. Net production refers to
neutrophil extracellular traps. When these guys give
their lives for you, they will extrude their DNA, which will pick up and
hold hydrolytic enzymes, and this will form
a trap to kill and disable and generally tie up any pathogen that's
threatening you at the time. Here we have a ghost

of the neutrophil that died trying to save someone. The other three cell types that are also myeloid granulocytes are the mast cell, the basophils, and the eosinophils. These three are all what we would call weakly phagocytic, and that seems to mean that while they can't swallow a whole bunch of bacteria or debris whole, they are stampling their environment to get instructions and information to decide how best to defend you. They're basically asking the question, what pathogen is causing the problem? How bad is the infection? Are there lots of inflammatory signals and dead cells in the vicinity of the infected tissue? These three cells are going to be important in Th2 defenses against worms in the environment. First, we look at the mast cell. Mast cell service immune regulators. They help decide whether or not to switch on that Th2 response in the absence of strong inflammatory signals. In this cartoon, you can see that these guys have the antibody receptors for IgE antibodies and interestingly, bind those antibodies before they bind antigen. They essentially will bind the antibodies and use those antibodies as antennae or probes to look for specific signals of pathogens in the vicinity. Their granules stain with basic stains, and that includes compounds like histamines and other signaling molecules. These are the guys that will signal your running nose, mucus production, and itching if you have an allergic response. That response will help you to flush out the offending irritants. Instead of circulating in and out of capillaries like other granulocytes, mast cells associate with a specific tissue and they mature there and they hang out there. This illustration shows two mast cells indicated by the yellow arrows, and notice these guys have round nuclei. The others all have funny-shaped nuclei with lobes, and that suggests that the lobing functions to elongate the nucleus preventing damage as they squeeze in and out of the capillaries. Here's a cartoon of a basophil. Basophils are similar to mast cells in function and granular content, which also dye blue. If you will notice, they also pre-bind IgE antibodies. Here's a rendering of a basophil by Bruce Blow who also drew one of our neutrophils. You can see it has a complex, almost C-shaped nucleus, consistent with its moving in and out of the circulatory system. Here is a blood smear, where you can see the C-shaped nucleus and the stain granules. In this case, they're more of a bluish violet because of a slightly different staining protocol. Again, earlier textbooks do not describe these as phagocytic, but they do phagocytize, however, weekly, and again, it's more of a sampling response than a full-on disposal of pathogens. Our last cell is here, the eosinophil. This is Daisy Chung's rendering of an eosinophil. Note that the FC receptors are empty. Eosinophils can bind to more than just IgE antibodies. They can also bind to inflammatory IgG antibodies as well and can help get rid of a really serious potentially lethal worm infection. In Bill Blau's illustration, you can see the two lobes of the bilobed nucleus connected by a narrow isthmus, and you can see that the granules are staining red. In this blood side, it's a little bit harder to see the two lobes of the nucleus, and the granules,

however, are clearly red. Again, they have stained with a stain called eosin red and acidic stain. Again, these are weakly phagocytic. But when they pick up signals that this is a dangerous worm infection, they will adjust to a stronger attack. You might be looking at these last three cells and saying, these cells are devoted to protecting me from worms, but worms? I don't have worms. Well, your ancestors had worms, and they had lots of worms. Worm parasites are still a big compromise to people's public health in the third world. One of the reasons you're doing much better than most people in most parts of the world is because you've got clean water and proper sewage disposal, which is how we started this whole lecture. These guys no longer have as much to do. There's something called the hygiene hypothesis that suggests that allergies may arise when these cells have nothing to do and begin to respond to random antigen.